

What is claimed is:

1 1. A method for robustly producing a motion compensated interpolation video frame, the
2 method comprising:

3 constructing N motion compensated interpolated frames between two existing
4 frames F1 and F2, wherein N comprises an integer with a value of at least
5 2; and
6 fusing the N motion compensated interpolated frames into a single motion
7 compensated interpolated frame.

1 2. The method of claim 1 wherein constructing each of the N motion compensated
2 interpolated frames between the two existing frames F1 and F2 further comprises:

3 selecting a first set of pixels in F1, wherein the pixel sets selected for each of the
4 N motion compensated frames varies;

5 selecting a corresponding second set of pixels in F2, wherein the corresponding
6 pixel sets selected for each of the N motion compensated frames varies;

7 generating a first mesh for the first set of pixels and a second mesh for the second
8 set of pixels;

9 estimating a first flow of motion from the first set of pixels to the second set of
10 pixels, and a second flow of motion from the second set of pixels to the
11 first set of pixels;

12 generating a first motion compensated mesh based on the first mesh and the first
13 estimated flow of motion, and a second motion compensated mesh based
14 on the second mesh and the second estimated flow of motion;

15 computing a first warped image by warping F1 using the first mesh and the first
16 motion compensated mesh, and a second warped image by warping F2
17 using the second mesh and the second motion compensated mesh; and
18 linearly combining the first warped image and the second warped image.

1 3. The method of claim 2 wherein selecting a set of pixels in a frame further comprises:
2 classifying some pixels in the frame as having high spatial frequency contents and
3 selecting the classified pixels, wherein the specific classification criteria is
4 different for each of the N motion compensated frames.

1 4. The method of claim 2 wherein generating a mesh for a set of pixels further
2 comprises:
3 fitting a polygonal mesh to the set of pixels.

1 5. The method of claim 4 wherein fitting a polygonal mesh to a set of pixels further
2 comprises:
3 applying a Delaunay triangulation to the set of pixels, using edges of the
4 associated frame as imposed boundaries.

1 6. The method of claim 2 wherein estimating a flow of motion between two sets of pixels
2 further comprises:
3 applying an optical flow constraint equation to the first set of pixels, the optical
4 flow constraint equation comprising $x * u + y * v + t = 0$, wherein u and v
5 are unknown components of the flow and x, y and t stand for
6 differentiation.

1 7. The method of claim 1 wherein fusing the N motion compensated interpolated frames
2 into a single, motion compensated interpolated frame further comprises:

3 for each pixel x, y in a final fused motion compensated interpolated frame:

4 applying a scalar median filter componentwise to a corresponding pixel in

5 each of the N motion compensated interpolated frames 1-N to

6 produce a resulting pixel x', y'; and

7 setting x, y to a corresponding pixel from a one of the N motion

8 compensated interpolated frames that is color nearest to x', y'.

1 8. A computer readable medium containing a computer program product for robustly
2 producing a motion compensated interpolation video frame, the computer program product
3 comprising:

4 program code for constructing N motion compensated interpolated frames

5 between two existing frames F1 and F2, wherein N comprises an integer

6 with a value of at least 2; and

7 program code for fusing the N motion compensated interpolated frames into a

8 single motion compensated interpolated frame.

1 9. The computer readable medium of claim 8 wherein the program code for constructing
2 each of the N motion compensated interpolated frames between the two existing frames F1 and
3 F2 further comprises:

4 program code for selecting a first set of pixels in F1, wherein the pixel sets

5 selected for each of the N motion compensated frames varies;

6 program code for selecting a corresponding second set of pixels in F2, wherein
7 the corresponding pixel sets selected for each of the N motion
8 compensated frames varies;
9 program code for generating a first mesh for the first set of pixels and a second
10 mesh for the second set of pixels;
11 program code for estimating a first flow of motion from the first set of pixels to
12 the second set of pixels, and a second flow of motion from the second set
13 of pixels to the first set of pixels;
14 program code for generating a first motion compensated mesh based on the first
15 mesh and the first estimated flow of motion, and a second motion
16 compensated mesh based on the second mesh and the second estimated
17 flow of motion;
18 program code for computing a first warped image by warping F1 using the first
19 mesh and the first motion compensated mesh, and a second warped image
20 by warping F2 using the second mesh and the second motion compensated
21 mesh; and
22 program code for linearly combining the first warped image and the second warped
23 image.

1 10. The computer readable medium of claim 9 wherein the program code for selecting a
2 set of pixels in a frame further comprises:

3 program code for classifying some pixels in the frame as having high spatial
4 frequency contents and selecting the classified pixels, wherein the specific

5 classification criteria is different for each of the N motion compensated
6 frames.

1 11. The computer readable medium of claim 9 wherein the program code for generating
2 a mesh for a set of pixels further comprises:
3 program code for fitting a polygonal mesh to the set of pixels.

1 12. The computer readable medium of claim 11 wherein the program code for fitting a
2 polygonal mesh to a set of pixels further comprises:
3 program code for applying a Delaunay triangulation to the set of pixels, using
4 edges of the associated frame as imposed boundaries.

1 13. The computer readable medium of claim 9 wherein the program code for estimating
2 a flow of motion between two sets of pixels further comprises:
3 program code for applying an optical flow constraint equation to the first set of
4 pixels, the optical flow constraint equation comprising $x * u + y * v + t =$
5 0, wherein u and v are unknown components of the flow and x, y and t
6 stand for differentiation.

1 14. The computer readable medium of claim 8 wherein the program code for fusing the
2 N motion compensated interpolated frames into a single, motion compensated interpolated frame
3 further comprises:
4 program code for, for each pixel x, y in a final fused motion compensated
5 interpolated frame:

6 applying a scalar median filter componentwise to a corresponding pixel in
7 each of the N motion compensated interpolated frames 1-N to
8 produce a resulting pixel x' , y' ; and
9 setting x , y to a corresponding pixel from a one of the N motion
10 compensated interpolated frames that is color nearest to x' , y' .

1 15. A computer system for robustly producing a motion compensated interpolation video
2 frame, the computer system comprising:

3 means for constructing N motion compensated interpolated frames between two
4 existing frames F1 and F2, wherein N comprises an integer with a value of
5 at least 2; and
6 means for fusing the N motion compensated interpolated frames into a single
7 motion compensated interpolated frame.

1 16. The computer system of claim 15 wherein the means for constructing each of the N
2 motion compensated interpolated frames between the two existing frames F1 and F2 further
3 comprises:

4 means for selecting a first set of pixels in F1, wherein the pixel sets selected for
5 each of the N motion compensated frames varies;
6 means for selecting a corresponding second set of pixels in F2, wherein the
7 corresponding pixel sets selected for each of the N motion compensated
8 frames varies;
9 means for generating a first mesh for the first set of pixels and a second mesh for
10 the second set of pixels;

11 means for estimating a first flow of motion from the first set of pixels to the
12 second set of pixels, and a second flow of motion from the second set of
13 pixels to the first set of pixels;
14 means for generating a first motion compensated mesh based on the first mesh
15 and the first estimated flow of motion, and a second motion compensated
16 mesh based on the second mesh and the second estimated flow of motion;
17 means for computing a first warped image by warping F1 using the first mesh and
18 the first motion compensated mesh, and a second warped image by
19 warping F2 using the second mesh and the second motion compensated
20 mesh; and
21 means for linearly combining the first warped image and the second warped image.

1 17. The computer system of claim 16 wherein the means for selecting a set of pixels in a
2 frame further comprises:

3 means for classifying some pixels in the frame as having high spatial frequency
4 contents and selecting the classified pixels, wherein the specific
5 classification criteria is different for each of the N motion compensated
6 frames.

1 18. The computer system of claim 16 wherein the means for generating a mesh for a set
2 of pixels further comprises:

3 means for fitting a polygonal mesh to the set of pixels.

1 19. The computer system of claim 18 wherein the means for fitting a polygonal mesh to
2 a set of pixels further comprises:

3 means for applying a Delaunay triangulation to the set of pixels, using edges of
4 the associated frame as imposed boundaries.

1 20. The computer system of claim 16 wherein the means for estimating a flow of motion
2 between two sets of pixels further comprises:

3 means for applying an optical flow constraint equation to the first set of pixels,
4 the optical flow constraint equation comprising $x * u + y * v + t = 0$,
5 wherein u and v are unknown components of the flow and x, y and t stand
6 for differentiation.

1 21. The computer system of claim 15 wherein the means for fusing the N motion
2 compensated interpolated frames into a single, motion compensated interpolated frame further
3 comprises:

4 means for, for each pixel x, y in a final fused motion compensated interpolated
5 frame:

6 applying a scalar median filter componentwise to a corresponding pixel in
7 each of the N motion compensated interpolated frames 1-N to
8 produce a resulting pixel x', y'; and

9 setting x, y to a corresponding pixel from a one of the N motion

10 compensated interpolated frames that is color nearest to x', y'.

1 22. A computer system for robustly producing a motion compensated interpolation video
2 frame, the computer system comprising:

3 a software portion configured to construct N motion compensated interpolated
4 frames between two existing frames F1 and F2, wherein N comprises an
5 integer with a value of at least 2; and
6 a software portion configured to fuse the N motion compensated interpolated
7 frames into a single motion compensated interpolated frame.

1 23. The computer system of claim 22 wherein the software portion configured to
2 construct each of the N motion compensated interpolated frames between the two existing
3 frames F1 and F2 further comprises:

4 a software portion configured to select a first set of pixels in F1, wherein the pixel
5 sets selected for each of the N motion compensated frames varies;
6 a software portion configured to select a corresponding second set of pixels in F2,
7 wherein the corresponding pixel sets selected for each of the N motion
8 compensated frames varies;
9 a software portion configured to generate a first mesh for the first set of pixels and
10 a second mesh for the second set of pixels;
11 a software portion configured to estimate a first flow of motion from the first set
12 of pixels to the second set of pixels, and a second flow of motion from the
13 second set of pixels to the first set of pixels;
14 a software portion configured to generate a first motion compensated mesh based
15 on the first mesh and the first estimated flow of motion, and a second
16 motion compensated mesh based on the second mesh and the second
17 estimated flow of motion;

18 a software portion configured to compute a first warped image by warping F1
19 using the first mesh and the first motion compensated mesh, and a second
20 warped image by warping F2 using the second mesh and the second
21 motion compensated mesh; and
22 a software portion configured to linearly combine the first warped image and the
23 second warped image.

1 24. The computer system of claim 23 wherein the software portion configured to select a
2 set of pixels in a frame further comprises:

3 a software portion configured to classify some pixels in the frame as having high
4 spatial frequency contents and selecting the classified pixels, wherein the
5 specific classification criteria is different for each of the N motion
6 compensated frames.

1 25. The computer system of claim 23 wherein the software portion configured to
2 generate a mesh for a set of pixels further comprises:

3 a software portion configured to fit a polygonal mesh to the set of pixels.

1 26. The computer system of claim 25 wherein the software portion configured to fit a
2 polygonal mesh to a set of pixels further comprises:

3 a software portion configured to apply a Delaunay triangulation to the set of
4 pixels, using edges of the associated frame as imposed boundaries.

1 27. The computer system of claim 23 wherein the software portion configured to
2 estimate a flow of motion between two sets of pixels further comprises:

3 a software portion configured to apply an optical flow constraint equation to the
4 first set of pixels, the optical flow constraint equation comprising $x * u + y$
5 $* v + t = 0$, wherein u and v are unknown components of the flow and x , y
6 and t stand for differentiation.

1 28. The computer system of claim 22 wherein the software portion configured to fuse the
2 N motion compensated interpolated frames into a single, motion compensated interpolated frame
3 further comprises:

4 a software portion configured to, for each pixel x , y in a final fused motion
5 compensated interpolated frame:

6 apply a scalar median filter componentwise to a corresponding pixel in

7 each of the N motion compensated interpolated frames 1- N to

8 produce a resulting pixel x' , y' ; and

9 set x , y to a corresponding pixel from a one of the N motion compensated

10 interpolated frames that is color nearest to x' , y' .